



Model Course Outline

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The following is a course proposal for a 45 to 50 hour introductory geospatial science awareness course. The content of the course outline is based upon the Geospatial Technology Competency Model (GTCM).

Proposed Title of Geospatial Awareness Course:

Seeing the World: The Fundamentals of Geospatial Science

Proposed Course Description:

Introduction to the fundamental concepts of Geographic Information Science and Technology (GIS&T) including Geographic Information Systems (GIS), Global Positioning Systems (GPS), cartography, remote sensing, and spatial analysis. Exploration of how geospatial technologies are used in addressing human and environmental issues.

Pre-req.: None – or if it articulates, may need Introductory College Algebra or the Equivalent

Computer Requirement: Access to computer with Internet connection in order to complete web-based exercises.

Proposed Student Learning Outcomes (SLO's):

1. The student will describe the fundamental concepts and applications of Geographic Information Science and Technology (GIS&T), including the problems and challenges of representing change over space and time.
2. The student will demonstrate the use of web mapping tools to study and develop possible solutions to real world problems.
3. The student will describe and explain the historical development of GIS&T and how GIS&T helps to solve problems of a spatial context.
4. The student will demonstrate basic proficiency in map reading, interpretation, and design principles, including map projections and the geographic grid.
5. The student will describe the fundamental concepts and applications of remote sensing and Global Positioning Systems.
6. The student will describe and demonstrate how to access different sources of data, describe the process of creating data, and discuss the fundamental concepts of data quality.

Proposed Course Outline:

I. Introduction to Geospatial Technology and Spatial Thinking

The committee recommended that the class include the following core course objectives:

- Describe and provide examples of how geospatial technologies are being applied in the areas of transportation, the environment, local government, business, and other areas.



- Discuss the components of geospatial technology (for example, remote sensing, GIS, and GPS) and its relationship to other fields.
- Describe the fundamental concepts and applications of GIS, including the problems and challenges of representing change over time.
- Describe and explain the historical development of GIS and how GIS helps to solve problems of a spatial context.
- Identify, explain, and interpret spatial patterns and relationships, such as how places are similar and different, the nature of transitions between places, and how places are linked at local, regional, and/or global scales.
- Discuss how people, places, and regions are linked by global networks and processes (for example, globalization, international trade, immigration, Internet technology, global climate system).
- Demonstrate awareness of the various stakeholders (for example, the private sector, non-profit organizations, and government agencies) and their respective roles that comprise the geospatial technology industry.
- Discuss the historical origins of the geospatial technology industry.
- Compare the capabilities and limitations of different types of geospatial software.

The committee recommended including the following course objectives if class time permits:

- Recognize automated GIS tasks, such as route generation, incident response, and land use change analysis.
- Describe the benefits and risks of an organization's investment in geospatial technology, including value added and risks minimized.

The following objectives were not included in the model course outline due to one or more of the following reasons: 1) There was redundancy with other objective(s) either in this section or another section; 2) The objective was not applicable, beyond the scope, or too advanced for an awareness course:

- Demonstrate a working knowledge of GIS hardware and software capabilities, including real time GPS/GIS mapping systems.
- Acquire and integrate a variety of field data, image data, vector data, and attribute data to create, update, and maintain GIS databases.
- Use geospatial hardware and software tools to digitize and georeference a paper map or plot.
- Recognize ethical implications of bidding and other business practices in geospatial business contexts and make reasoned decisions about appropriate actions.
- Discuss the respective roles of the private sector, universities, non-profit organizations, and government agencies in the geospatial market.



II. Methods of Problem Solving and Analytical Thinking

The committee recommended that the class include the following core course objectives:

- Apply critical-thinking skills to solve problems by generating, evaluating, and implementing solutions and alternatives.
- Describe the scientific method, including the formulation of a problem, the collection of data through observation and experiment, and the formulation and testing of a hypothesis.
- Use logic, reasoning, and analysis to address geospatial problems.

III. Projections and Coordinate Systems

The committee recommended that the class include the following core course objectives:

- Describe characteristics and appropriate uses of common geospatial coordinate systems.
- Describe the importance of generalization methods and the concept of representational scale.
- Discuss the roles of several geometric approximations of the earth's shape, such as geoids, ellipsoids, and spheres.
- Describe characteristics and appropriate uses of common map projections.
- Describe the relationship of horizontal datums to coordinate system grids and geometric approximations of the earth's shape.
- Describe how the Earth is measured and modeled for the purposes of positioning.

IV. Cartography

The committee recommended that the class include the following core course objectives:

- Demonstrate proficiency in map reading and interpretation.
- Demonstrate how the selection of data classification and/or symbolization techniques affects the message of the thematic map.
- Critique the design of a given map in light of its intended audience and purpose.
- Analyze the relationship between scale and the level of geographic detail in a representation.
- Employ cartographic design principles to create and edit visual representations of geospatial data, including maps, graphs, and diagrams.

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- Develop and modify map layouts for appropriate cartographic presentation.

V. Geospatial Data



The committee recommended that the class include the following core course objectives:

- Identify and describe basic types of maps and geographic data used with a GIS.
- Compare and contrast raster and vector data structures and operations.
- Compare advantages and disadvantages of standard spatial data models, including the nature of vector, raster, and object-oriented models.
- Compare vector and raster representations of terrain elevation.
- Describe and demonstrate the procedure for collecting, locating, and accessing data to be used in a GIS.
- Describe how address-referenced census data are matched to specific geographic locations.
- Give examples of how GIS has been used in the modeling of physical and human processes.
- Discuss the art and science of representing real-world phenomena in GIS.

The committee recommended including the following course objectives if class time permits:

- Acquire and view digital elevation data from the National Elevation Dataset.
- Describe the concepts of fields and objects and their fundamental significance.
- Specify uses of standard non-spatial data models.
- List and describe characteristics and status of the USGS National Map.
- Use the World Wide Web to find Landsat data for a particular place and time.

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- Describe how surfaces are modeled.
- Describe how to model the world and create a useful geographic database.
- Outline the main geographic models used in GIS today and their strengths and weaknesses.
- Describe the fundamental concepts of GIS data modeling.
- Identify the needs of spatial modeling and how these needs are being addressed by current trends in GIS software.

VI. Data Quality

The committee recommended that the class include the following core course objectives:

- Discuss the elements of geospatial data quality, including topology, geometric accuracy, thematic accuracy, resolution, precision, and fitness for use.
- Be familiar with the problems associated with place-names, street addresses, and other systems.
- Discuss the concept of uncertainty, and the ways in which it arises from imperfect representation of geographic phenomena.



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- Calculate and interpret statistical measures of the accuracy of a digital data set, such as Root Mean Square Error (RMSE).
- Identify data quality and integration problems likely to be associated with geospatial and attribute data acquired with legacy systems and processes.
- Define topology and explain why and how it is encoded in TIGER.
- In the context of a given geospatial project, explain the difference between quality control and quality assurance.
- Describe key topology concepts and why topology is useful for data validation, analysis, and editing.

VII. Methods of Spatial Analysis

The committee recommended that the class include the following core course objectives:

- Describe examples of geospatial data analysis in which spatial relationships such as distance, direction, and topologic relationships (e.g. adjacency, connectivity, and overlap) are particularly relevant.
- Describe the use of overlaying, buffering, and basic spatial statistics to analyze feature and spatial relationships.
- Use geospatial software tools to perform basic GIS analysis functions.

The committee recommended including the following course objectives if class time permits:

- Describe the process of geocoding addresses and identify its value.
- Discuss the problems of applying methods of statistical inference to geographic data.
- Measure properties of surfaces and areas.

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- Use quantitative methods to process spatial data for the purpose of making calculations, models, and inferences about space, spatial patterns, and spatial relationships.
- Create models using GIS software to analyze spatial data.



VIII. Satellite Positioning and Other Measurement Systems

The committee recommended that the class include the following core course objectives:

- Describe the principles behind GPS, and some of its applications, including recreational, mapping, and surveying.
- Describe the basic components and operations of the Global Navigation Satellite System (GNSS), including the Global Positioning System and similar systems.
- Describe how radio signals broadcast by Global Positioning System satellites are used to calculate positions on the surface of the Earth.
- State the kinds and magnitude of error associated with uncorrected GPS positioning.
- Identify and explain methods used to improve the accuracy of GPS positioning.

The committee recommended including the following course objectives if class time permits:

- Collect and integrate GNSS/GPS positions and associated attribute data with other geospatial data sets.
- Explain the distinction between GNSS data post-processing (such as U.S. National Geodetic Survey's Online Positioning User Service) and real time processing (such as Real-Time Kinematic).
- List and explain the procedures land surveyors use to produce positional data, including traversing, triangulation, and trilateration.

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- Compare differential GNSS and autonomous GNSS.
- Identify and describe characteristics of inertial measurement systems and other geospatial measurement systems.
- Plan a GNSS data acquisition mission that optimizes efficiency and data quality.

IX. Remote Sensing and Photogrammetry

The committee recommended that the class include the following core course objectives:

- Explain the difference between active and passive sensors, citing examples of each and how they are deployed.
- Describe the electromagnetic spectrum and the fundamental principles of electromagnetic radiation.



- Differentiate the several types of resolution that characterize remotely-sensed imagery, including spatial, spectral, radiometric, temporal, and extent.
- Compare and contrast the characteristics of image data produced by photography and digital remote sensing systems.
- Use the concept of the "electromagnetic spectrum" to explain the difference between optical sensors, microwave sensors, multispectral and hyperspectral sensors.
- Define "orthoimagery" in terms of terrain correction and georeferencing.
- Explain the use of sampling ground truth data for quality assurance in remote sensing.

The committee recommended including the following course objectives if class time permits:

- Explore the interaction of radiation with various media, including surfaces and the atmosphere.
- Explain why and how remotely sensed image data are processed.

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- Acquire information needed to compare the capabilities and limitations of various sensor types in the context of project requirements.
- Identify remote sensing platforms.

X. Geospatial Technology: Professionalism and Society

The committee recommended that the class include the following core course objectives:

- Identify allied fields that rely on geospatial technology and that employ geospatial professionals.
- Identify legal, ethical, and business considerations that affect an organization's decision to share geospatial data.
- Discuss codes of professional ethics and rules of conduct for geospatial professionals.

The committee recommended including the following course objective if class time permits:

- Participate in scientific and professional organizations and coordinating organizations.

XI. Trends in Geospatial Technology

The committee recommended that the class include the following core course objectives:



- Explain how the relationship between GIS and other technologies have an impact on future developments.
- Explore the capabilities of mobile devices, including cell phones, with regards to mobile GIS.
- Describe how 3-D geovisualization and virtual reality improve our ability to understand the world.
- Discuss the technologies that support real-time acquisition and distribution of geographic information.
- Explore the service-oriented architectures and mashups that combine GIS services from different Web sites.
- Discuss how GIS can be distributed instead of centralized.
- Describe geoportals that allow remotely stored data to be discovered and accessed.
- Explore the concept of augmented reality, and its relationship to location-based services.

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